Unit 3: Fields of Engineering

Content Area: **Template**
Course(s):
Time Period: **Full Year**
Length: **Full Year**
Status: **Published**

UNIT RATIONALE

Unit 3 focuses on introducing students to various engineering fields, exploring their applications, and understanding the interdisciplinary nature of engineering. Students will delve into specific subtopics related to environmental engineering, robotics and artificial intelligence, and biomedical engineering. Through hands-on activities, design challenges, and critical thinking, students will develop an appreciation for the diverse fields of engineering and their impact on society.

ESSENTIAL QUESTIONS

Subtopic 3.1: Introduction to Engineering Fields
  - What is engineering and why is it important?
  - How do different engineering fields contribute to solving real-world problems?

Subtopic 3.2: Environmental Engineering
  - What is environmental engineering and its significance in addressing environmental challenges?
  - How do environmental engineers develop sustainable solutions for improving global living conditions?

Subtopic 3.3: Robotics, Artificial Intelligence, and Automation Engineering
  - What are the principles behind robotics, artificial intelligence, and automation?
  - How do engineers develop robotic systems and intelligent machines?

STANDARDS

NEW JERSEY STUDENT LEARNING STANDARDS: CONTENT AREA

New Jersey (NJSLS) - Grades 6-8 - Computer Science and Design Thinking (2020)

8.1.8.CS.1:
Recommend improvements to computing devices in order to improve the ways users interact with the devices.
8.1.8.CS.2:
Design a system that combines hardware and software components to process data.

8.1.8.CS.3:		

Justify design decisions and explain potential system trade-offs.

8.1.8.CS.4:		

Systematically apply troubleshooting strategies to identify and resolve hardware and software problems in computing systems.

8.2.8.ED.5:		

Explain the need for optimization in a design process.

8.2.8.ED.6:		

Analyze how trade-offs can impact the design of a product.

8.2.8.ITH.2:		

Compare how technologies have influenced society over time.

8.2.8.ITH.3:		

Evaluate the impact of sustainability on the development of a designed product or system.

8.2.8.ITH.4:		

Identify technologies that have been designed to reduce the negative consequences of other technologies and explain the change in impact.

CS.6-8.8.1.8.CS.1	Recommend improvements to computing devices in order to improve the ways users interact with the devices.
CS.6-8.8.1.8.CS.2	Design a system that combines hardware and software components to process data.
CS.6-8.8.1.8.CS.3	Justify design decisions and explain potential system trade-offs.
CS.6-8.8.1.8.CS.4	Systematically apply troubleshooting strategies to identify and resolve hardware and software problems in computing systems.
CS.6-8.8.2.8.ED.5	Explain the need for optimization in a design process.
CS.6-8.8.2.8.ED.6	Analyze how trade-offs can impact the design of a product.
CS.6-8.8.2.8.ITH.2	Compare how technologies have influenced society over time.
CS.6-8.8.2.8.ITH.3	Evaluate the impact of sustainability on the development of a designed product or system.
CS.6-8.8.2.8.ITH.4	Identify technologies that have been designed to reduce the negative consequences of other technologies and explain the change in impact.

NEW JERSEY STUDENT LEARNING STANDARDS: CAREER READINESS, LIFE LITERACIES AND KEY SKILLS

CS.6-8.8.1.8.CS.4	Systematically apply troubleshooting strategies to identify and resolve hardware and software problems in computing systems.
CS.6-8.8.2.8.ED.5	Explain the need for optimization in a design process.
CS.6-8.8.2.8.ED.6	Analyze how trade-offs can impact the design of a product.
CS.6-8.8.2.8.ITH.2	Compare how technologies have influenced society over time.

NEW JERSEY STUDENT LEARNING STANDARDS: COMPUTER SCIENCE AND DESIGN THINKING

CS.6-8.8.1.8.DA.1	Organize and transform data collected using computational tools to make it usable for a specific purpose.
CS.6-8.8.1.8.DA.2	Explain the difference between how the computer stores data as bits and how the data is displayed.
CS.6-8.8.1.8.DA.3	Identify the appropriate tool to access data based on its file format.
CS.6-8.8.1.8.DA.4	Transform data to remove errors and improve the accuracy of the data for analysis.
CS.6-8.8.1.8.DA.5	Test, analyze, and refine computational models.
CS.6-8.8.1.8.IC.1	Compare the trade-offs associated with computing technologies that affect individual's everyday activities and career options.
CS.6-8.8.1.8.IC.2	Describe issues of bias and accessibility in the design of existing technologies.
CS.6-8.8.1.8.NI.3	Explain how network security depends on a combination of hardware, software, and practices that control access to data and systems.
CS.6-8.8.1.8.NI.4	Explain how new security measures have been created in response to key malware events.

PRE-ASSESSMENTS

Students will complete a pre-assessment to determine their knowledge of the fields of engineering.

INSTRUCTIONAL PLAN

MODULE 3

Subtopic 1: Introduction to the fields of engineering

Subtopic 2: Environmental Engineering

Subtopic 3: Robotics and Artificial Intelligence

Subtopic 3.1

Subtopic 3.1: Introduction to Engineering Fields

Essential Questions:
1. What are the different fields of engineering and their applications?
2. How does engineering contribute to solving real-world problems?

Learning Intentions:
1. Explore various fields of engineering and their key principles.
2. Understand the role of engineering in addressing societal challenges and improving people's lives.

Success Criteria:
1. Students can identify and describe different engineering disciplines and their applications.
2. Students can explain the importance of engineering in solving complex problems and making advancements.

Learning Strategies:
1. Guest speakers from different engineering fields sharing their experiences and work.
2. Interactive activities and demonstrations highlighting engineering principles.
3. Collaborative research projects on notable engineering achievements and their impact on society.

1. Title: "Engineering the Future: Crash Course Engineering #1"
https://www.youtube.com/watch?v=18uDutyIDa4

2. Title: "What is Engineering? | National Society of Professional Engineers"
https://www.youtube.com/watch?v=L9V-7BIZ47Y

3. Title: "Types of Engineering | Learn Engineering"
https://www.youtube.com/watch?v=hK3p9ja_ZIE

4. Title: "A Day in the Life of an Engineer - Engineering as a Career"
https://www.youtube.com/watch?v=1gtxRwrO9xo

5. Title: "Engineering Inspiration - A Tribute to Engineers"
https://www.youtube.com/watch?v=b9cMykAjeoQ

Projects:
1. Career Exploration Brochure:
   - Students research different engineering disciplines and create a brochure that highlights the key features, applications, and career opportunities in each field.
   - Students design engaging visuals and include relevant information to showcase the diverse areas of engineering.

2. Engineering Design Challenge:
   - Students are presented with a real-world problem and work in teams to design and prototype a solution using available materials and resources.
   - Students document their design process, including brainstorming, sketching, testing, and iterating.

3. Engineering Field Investigation:
   - Students select an engineering field of interest and conduct research to explore its applications and recent

developments.
   - Students create a presentation or infographic summarizing their findings and present it to the class.

4. Engineering Innovations Showcase:
   - Students research significant engineering innovations or breakthroughs and create a visual display or interactive exhibit to showcase these advancements.
   - Students incorporate multimedia elements and engaging hands-on activities to educate others about the impact of engineering on society.

Subtopic 3.2

Subtopic 3.2: Environmental Engineering

Essential Questions:
1. How can engineering contribute to environmental conservation and sustainability?
2. What technologies and strategies are used in environmental engineering to address environmental challenges?

Learning Intentions:
1. Understand the role of environmental engineering in addressing environmental issues.
2. Explore technologies and design strategies used in environmental engineering projects.

Success Criteria:
1. Students can explain the importance of environmental engineering in preserving the environment.
2. Students can identify and evaluate technologies and strategies used in environmental engineering projects.

Learning Strategies:
1. Case studies and discussions on environmental engineering projects.
2. Field trips or virtual tours to environmental engineering facilities.
3. Collaborative projects focusing on designing solutions to environmental challenges.

1. Title: "Introduction to Environmental Engineering | National Society of Professional Engineers"
https://www.youtube.com/watch?v=dC8ksg2tUOQ

2. Title: "What is Environmental Engineering? | Columbia Engineering"
https://www.youtube.com/watch?v=PWwWVByo4QI

3. Title: "The Role of Environmental Engineers | Brown and Caldwell"
https://www.youtube.com/watch?v=eIUqCa5s6Sg

4. Title: "Sustainable Engineering: Crash Course Engineering #4"

5. Title: "Environmental Engineering: Water Treatment"

Projects:
1. Water Filtration System:
   - Students design and construct a water filtration system using available materials and learn about different methods of water treatment.
   - Students test and evaluate the efficiency of their filtration system by analyzing the quality of filtered water.

2. Renewable Energy Design:
   - Students research different renewable energy sources (e.g., solar, wind, hydro) and design a sustainable energy system for a specific location.
   - Students consider factors such as energy production, environmental impact, and cost-effectiveness in their design.

3. Green Building Design:
   - Students explore sustainable building practices and design a green building model using recycled materials and energy-efficient features.
   - Students present their design, explaining the ecological benefits and energy-saving strategies incorporated.

4. Environmental Impact Assessment:
   - Students choose an environmental issue (e.g., pollution, deforestation) and conduct an impact assessment.
   - Students analyze the causes and consequences of the issue, propose mitigation strategies, and present their findings and recommendations.

Subtopic 3.3

Subtopic 3.3: Robotics, Artificial Intelligence, and Automation Engineering

Essential Questions:
1. What is the role of robotics, artificial intelligence, and automation in engineering?
2. How do robotics and AI technologies impact various industries and daily life?

Learning Intentions:
1. Understand the applications of robotics, artificial intelligence, and automation in engineering.
2. Explore the benefits and challenges associated with these technologies.

Success Criteria:
1. Students can explain the concepts of robotics, artificial intelligence, and automation and their relevance to

engineering.

2. Students can identify and evaluate the impact of robotics and AI technologies in different fields.

Learning Strategies:

1. Demonstrations and hands-on activities with robotics and AI technologies.

2. Guest speakers from industries that utilize robotics and AI.

3. Collaborative projects involving the design and programming of robotic systems.

1. Title: "What is Robotics and Artificial Intelligence? | Robotics and AI - Future Technologies"
https://www.youtube.com/watch?v=YxXOAT8dSUU

2. Title: "Robotics and Automation Engineering | National Society of Professional Engineers"
https://www.youtube.com/watch?v=5ZkmpvQtd-E

3. Title: "How AI is Changing the Face of Engineering | Engineering World"
https://www.youtube.com/watch?v=diCQNFBCayI

4. Title: "The Rise of AI and Robotics: Crash Course Computer Science #38"
https://www.youtube.com/watch?v=JXeJANDKwDc

5. Title: "The Future of Robotics: AI and Robotics Documentary"
https://www.youtube.com/watch?v=Vu9nqzESP1I

Projects:

1. Robotic Arm Design and Programming:
   - Students design and build a robotic arm using materials like cardboard, strings, and motors.
   - Students program the arm to perform specific tasks or movements, such as picking up objects or drawing.

2. Autonomous Vehicle Challenge:
   - Students work in teams to design and program autonomous vehicles using microcontrollers or robotics kits.
   - Students test and refine their vehicle's ability to navigate a predetermined course without human intervention.

3. AI Chatbot Creation:
   - Students learn about natural language processing and create an AI chatbot using platforms like Dialogflow or Chatfuel.
   - Students design conversational flows and train their chatbots to respond to user inputs.

4. Automation in Manufacturing:

   - Students research the use of automation in manufacturing processes and identify areas where automation can improve efficiency.

   - Students design and present proposals for implementing automation systems in a specific manufacturing scenario.

REFLECTIONS

INTERDISCIPLINARY CONNECTIONS: NEW JERSEY STUDENT LEARNING STANDARDS FOR ELA, SOCIAL STUDIES, SCIENCE AND/OR MATHEMATICS

MA.7.RP	Ratios and Proportional Relationships
MA.7.RP.A	Analyze proportional relationships and use them to solve real-world and mathematical problems.
MA.7.RP.A.1	Compute unit rates associated with ratios of fractions, including ratios of lengths, areas and other quantities measured in like or different units.
MA.7.RP.A.2	Recognize and represent proportional relationships between quantities.
MA.7.RP.A.2a	Decide whether two quantities are in a proportional relationship, e.g., by testing for equivalent ratios in a table or graphing on a coordinate plane and observing whether the graph is a straight line through the origin.
MA.7.NS.A	Apply and extend previous understandings of operations with fractions to add, subtract, multiply, and divide rational numbers.
MA.7.NS.A.1	Apply and extend previous understandings of addition and subtraction to add and subtract rational numbers; represent addition and subtraction on a horizontal or vertical number line diagram.
MA.7.NS.A.1a	Describe situations in which opposite quantities combine to make 0.
MA.7.NS.A.1b	Understand $p + q$ as the number located a distance $|q|$ from p, in the positive or negative direction depending on whether q is positive or negative. Show that a number and its opposite have a sum of 0 (are additive inverses). Interpret sums of rational numbers by describing real-world contexts.
MA.7.EE.A	Use properties of operations to generate equivalent expressions.